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Subject:

2019 First Quarter Operation Maintenance and Monitoring Report,
Operable Unit 2, Northrop Grumman Systems Corporation and Naval Weapons
Industrial Reserve Plant (NWIRP) Sites, Bethpage, New York.
(NYSDEC Site #s 1-30-003A and B)

ENVIRONMENT

Dear Jason:

On behalf of Northrop Grumman Systems Corporation (Northrop Grumman), Arcadis is providing the NYSDEC with the 2019 First Quarter Operation Maintenance and Monitoring Report (Report). This Report was prepared to document the operation, maintenance, and monitoring (OM&M) activities conducted for the on-site portion of the Operable Unit 2 (OU2) groundwater remedy and the results of ongoing volatile organic compound (VOC) and inorganic monitoring in groundwater to meet the remedial objectives set forth in the March 2001 OU2 Record of Decision (ROD).

Table 1 summarizes OU2 remedial system performance operational data, total mass removal, and water balance. Tables 2, 3A and 3B provide the analytical results for remedial system water and vapor samples for this period, respectively. Tables 4A and 4B provide the air modeling inputs and outputs and resulting analyses, based on quarterly vapor samples collected from the Tower 96 and Tower 102 systems, respectively, for this period. Tables 5A and 5B provide a summary of percent mass emittance of TCE from first quarter 2018 through first quarter 2019. Table 6 provides the validated analytical results of groundwater monitoring for this period. Figures 1 through 3 show the Locations of Wells and Onsite Groundwater Remedy, ONCT Groundwater Extraction and Treatment System Site Plan, and the ONCT Groundwater Extraction and Treatment System Schematic, respectively.

Date:
May 31, 2019

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Our ref:
NYNG2019.22TM.RPTI4
NYNG2019.23TM.NAVI4

Mr. Jason Pelton
May 31, 2019

Please contact us if you have any questions or comments.

Sincerely,

Arcadis of New York, Inc.



Christopher Engler, PE
New York PE-069748

Engineer of Record

Copies:

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TABLES



Table 1

Operational Summary for the On-Site Portion of the OU2 Groundwater Remedy, First Quarter 2019⁽¹⁾ Reporting Period
Operable Unit 2, Northrop Grumman Systems Corporation,
Bethpage, New York

	Quarterly Flow Rates (gpm)		Quarterly Flow Volumes (MG)			Quarterly VOC Concentrations (ppb)		VOC Mass Removed (lbs) ⁽²⁾	
	Design ⁽³⁾	Average ^(3,4)	Design ⁽³⁾	Actual ^(3,4)	% of Design	TCE ⁽⁵⁾	TVOC ⁽⁶⁾	Quarterly	Cumulative
Influent Groundwater									
Well 1 ⁽¹¹⁾	800	814	103.7	105.5	102%	589	620	547	50,284
Well 3R ⁽¹¹⁾	700	707	90.7	91.6	101%	333	380	291	92,718
Well 17 ⁽¹¹⁾	1,000	1,002	129.6	124.7	96%	108	130	135	54,268
Well 18 ⁽¹¹⁾	600	804	77.8	103.9	134%	41	65	56	6,873
Well 19 ⁽¹¹⁾	700	507	90.7	65.4	72%	112	140	77	9,043
Total⁽¹³⁾	3,800	3,834	493	491	100%	—	—	1,106	213,186
Effluent Groundwater⁽⁸⁾									
Calpine	100 - 400	86	--	11.2	--	--	--	--	--
OXY Biosparge ⁽¹⁰⁾	2 - 42	0	--	0	--	--	--	--	--
West Recharge Basins	1,112 - 1,455	2,567	--	332.7	--	--	0.6	--	--
South Recharge Basins ⁽¹²⁾	2,231	1,136	289.1	147.2	51%	--	1.1	--	--
Total⁽¹⁴⁾	—	3,789	--	491	--	—	—	—	—
Additional Flow to South Recharge Basins									
Storm Water Runoff Contributing to South Recharge Basins Flow Volume ⁽¹⁴⁾	—	--	--	17.0	--	--	--	--	--
Total Flow Volume to South Recharge Basins^(12,14,15)	—	—	289	164	57%	—	—	—	—
Treatment Efficiencies⁽⁹⁾									
Tower 96 System:	>99.9%								
Tower 102 System:	>99.9%								

Notes and abbreviations on last page.

Table 1
Operational Summary for the On-Site Portion of the OU2 Groundwater Remedy, First Quarter 2019⁽¹⁾ Reporting Period
Operable Unit 2, Northrop Grumman Systems Corporation,
Bethpage, New York

Notes and Abbreviations:

- (1) Quarterly reporting period: January 01, 2019 through March 31, 2019
- (2) "Design" flow rates were determined for the five remedial wells and for the South Recharge Basins based on computer modeling (ARCADIS G&M, Inc. 2003c, modified in April 2005). Flow rates for Calpine, OXY Biosparge and West Recharge Basins are typical flow rates and are provided for reader information. "Design" flow volumes represent the volume of water that should be pumped/discharged during the reporting period and is calculated by multiplying the design rate by the reporting period duration.
- (3) "Average" flow rates for the remedial wells represent the average actual pumping rates when the pumps are operational and do not take into account the time that a well is not operational. During this quarterly reporting period, the remedial wells operated for the following percentage of the time: Well 1 (100%), Well 3R (100%), Well 17 (96%), Well 18 (99.7%), and Well 19 (99.7%). "Actual" volumes are determined via totalized values computed by SCADA using the instantaneous flow rates transmitted from local flow meters.
- (4) "Average" flow rates for the system discharges represent the average flow rate during the entire reporting period and are determined by dividing the total flow during the reporting period by the reporting period duration. The Calpine and South Recharge Basins flow volumes are determined via totalized values computed by SCADA using the instantaneous flow rates transmitted from local flow meters. The West Recharge Basin flow is calculated by subtracting the cumulative flow to the other discharges from the total influent flow. Actual flow to the recharge basins is greater, as shown, because storm water combines with the plant effluent prior to discharge to the recharge basins.
- (5) The TCE and TVOC concentrations for the remedial wells are from the quarterly sampling event performed during this reporting period on February 13, 2019.
- (6) The TVOC concentration for the two sets of recharge basins are their respective average monthly SPDES concentration for the current quarter.
- (7) TVOC mass removed for the reporting period is calculated by multiplying the TVOC concentration from the quarterly sampling event and the quantity of water pumped during the reporting period.
- (8) There are four discharges for the effluent groundwater: South Recharge Basins, West Recharge Basins, Calpine Power Plant (Calpine), and Occidental Chemical Biosparge system (OXY Biosparge). Treated water is continuously discharged to the south and west recharge basins, and is available "on-demand" to both Calpine for use as make-up water, and the biosparge remediation system operated by OXY.
- (9) Treatment System Efficiencies are calculated by dividing the difference between the remedial well flow weighted influent and effluent TVOC concentrations by the remedial well flow weighted influent concentration.
- (10) Occidental Chemical has not reported any water usage for the OXY Biosparge system since May 2016.
- (11) The downtime during First Quarter 2019 was minor and due to typical operation and maintenance. Well 17, of Tower 102 of the ONCT System, was shut down on March 15 through March 18, 2019 due to a variable frequency drive (VFD) fault. The VFD cabinet ventilation fan was unable to be repaired, therefore it was replaced and Well 17 was restarted.
- (12) Flow was diverted from the South Basins to the West Basins to accommodate basin rehabilitation work at the center most of the South Basins. On March 28, 2019, South Basin and West Basin discharge rates returned to typical operating values following the western most and central South Basin maintenance completion.
- (13) Total pumpage/recharge rates are accurate to ±15% due to limitations in metering.
- (14) Storm Water Runoff Volume is calculated by multiplying the adjusted tributary area and NOAA precipitation data for the reporting periods. The adjusted tributary area is tributary area that is adjusted by the runoff coefficient to exclude the infiltration volume from the total rainfall volume. The tributary area, runoff coefficient, and adjusted tributary area are from Dvirka and Bartilucci Consulting Engineers' Storm Water Permit Evaluation Report (January, 28, 2010). The NOAA precipitation data are calculated as a sum of NOAA daily precipitation data for the reporting period. NOAA precipitation data are retrieved from Station GHCND:USW00054787 - FARMINGDALE REPUBLIC AIRPORT, NY US for October and December; Station GHCND:US1NYNS0030 - PLAINEDGE, NY US for November as data was not available for the typical
- (15) Total Flow Volume to South Recharge Basins is estimated as a sum of flow volumes contributed from the Effluent Groundwater to South Recharge Basins and from Storm Water Runoff to South Recharge Basins.

--	Not Applicable	NOAA	National Oceanic and Atmospheric Administration
µg/L	micrograms per liter	SCADA	Supervisory Controls and Data Acquisition
gpm	gallons per minute	SPDES	State Pollution Discharge Elimination System
lbs	pounds	TCE	trichloroethene
MG	million gallons	TVOC	total volatile organic compounds
		VOC	volatile organic compounds

Table 2
 Concentrations of Constituents in Remedial Wells and
 Treatment System Effluents, First Quarter 2019, Operable Unit 2,
 Northrop Grumman Systems Corporation,
 Bethpage, New York



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Constituents ⁽¹⁾ (units in µg/L)	Location ID: Sample ID: Sample Date:	WELL 1 WELL 1 2/13/2019	WELL 3R WELL 3R 2/13/2019	96 EFFLUENT 96 EFFLUENT 2/13/2019
<u>Volatile Organic Compounds (VOCs)⁽²⁾</u>				
1,1,1-Trichloroethane		< 1.3	0.64	< 0.50
1,1,2,2-Tetrachloroethane		< 2.5	< 1.0	< 1.0
1,1,2-Trichloroethane		< 2.5	< 1.0	< 1.0
1,1-Dichloroethane		< 2.5	1.4	< 1.0
1,1-Dichloroethene		2.0	3.8	< 0.50
1,2-Dichloroethane		< 2.5	< 1.0	< 1.0
1,2-Dichloropropane		4.4	< 1.0	< 1.0
2-Butanone (MEK)		< 25	< 10	< 10
2-Hexanone (MBK)		< 13	< 5.0	< 5.0
4-methyl-2-pentanone (MIK)		< 13	< 5.0	< 5.0
Acetone		< 25	< 10	< 10
Benzene		< 1.3	< 0.50	< 0.50
Bromodichloromethane		< 2.5	< 1.0	< 1.0
Bromoform		< 2.5	< 1.0	< 1.0
Bromomethane		< 5.0	< 2.0	< 2.0
Carbon Disulfide		< 5.0	< 2.0	< 2.0
Carbon Tetrachloride		< 2.5	< 1.0	< 1.0
Chlorobenzene		< 2.5	< 1.0	< 1.0
Chloroethane		< 2.5	< 1.0	< 1.0
Chloroform		< 1.3	< 0.50	< 0.50
Chloromethane		< 2.5	< 1.0	< 1.0
cis-1,2-Dichloroethene		5.4	4.0	< 0.50
cis-1,3-Dichloropropene		< 2.5	< 1.0	< 1.0
Dibromochloromethane		< 2.5	< 1.0	< 1.0
Ethylbenzene		< 2.5	< 1.0	< 1.0
Methylene Chloride		< 1.3	< 0.50	< 0.50
Styrene		< 2.5	< 1.0	< 1.0
Tetrachloroethene		16.6	30.8	< 0.50
Toluene		< 2.5	< 1.0	< 1.0
trans-1,2-Dichloroethene		< 1.3	< 0.50	< 0.50
trans-1,3-Dichloropropene		< 2.5	< 1.0	< 1.0
Trichloroethylene		589 D	333 EJ⁽⁴⁾	< 0.50
Trichlorotrifluoroethane (Freon 113)		2.2	3.4	< 0.50
Vinyl Chloride		< 1.3	1.7	< 0.50
Xylene-o		< 2.5	< 1.0	< 1.0
Xylene-m,p		< 2.5	< 1.0	< 1.0
Total VOCs ⁽³⁾		620	380	0
1,4-Dioxane ⁽²⁾		8.1	10	9.8

Notes and abbreviations on last page.

Table 2
 Concentrations of Constituents in Remedial Wells and
 Treatment System Effluents, First Quarter 2019, Operable Unit 2,
 Northrop Grumman Systems Corporation,
 Bethpage, New York



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Constituents ⁽¹⁾ (units in µg/L)	Location ID: Sample ID: Sample Date:	WELL 17 WELL 17 2/13/2019	WELL 18 WELL 18 2/13/2019	WELL 19 WELL 19 2/13/2019	WELL 19 REP 021319-RM-1 2/13/2019	102 EFFLUENT 102 EFFLUENT 2/13/2019
Volatile Organic Compounds (VOCs)⁽²⁾						
1,1,1-Trichloroethane		< 0.50	0.35 J	0.25 J	< 0.50	< 0.50
1,1,2,2-Tetrachloroethane		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethane		0.75 J	1.3	0.62 J	0.64 J	< 1.0
1,1-Dichloroethene		1.4	3.0	1.3	1.3	< 0.50
1,2-Dichloroethane		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2-Butanone (MEK)		< 10	< 10	< 10	< 10	< 10
2-Hexanone (MBK)		< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
4-methyl-2-pentanone (MIK)		< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Acetone		< 10	< 10	< 10	< 10	< 10
Benzene		< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Bromodichloromethane		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromoform		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromomethane		< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbon Disulfide		< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbon Tetrachloride		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorobenzene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloroethane		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloroform		< 0.50	< 0.50	0.38 J	< 0.50	< 0.50
Chloromethane		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
cis-1,2-Dichloroethene		2.5	2.6	15.0	15.4	< 0.50
cis-1,3-Dichloropropene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromochloromethane		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Methylene Chloride		< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Styrene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloroethene		18.9	15.0	6.8	6.7	< 0.50
Toluene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
trans-1,2-Dichloroethene		< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
trans-1,3-Dichloropropene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethylene		108	41.1	112	112	< 0.50
Trichlorotrifluoroethane (Freon 113)		2.9	1.4	1.0	< 0.50	< 0.50
Vinyl Chloride		< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Xylene-o		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Xylene-m,p		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total VOCs ⁽³⁾		130	65	140	140	0
1,4-Dioxane ⁽⁴⁾			7.3	5.7	4.6 J⁽⁵⁾	3.2 J⁽⁵⁾
						5.7

Notes and abbreviations on last page.

Table 2
Concentrations of Constituents in Remedial Wells and
Treatment System Effluents, First Quarter 2019, Operable Unit 2,
Northrop Grumman Systems Corporation,
Bethpage, New York

Notes and Abbreviations:

- (1) Results for the program are validated at 20% frequency, per protocols specified in OU2 Groundwater Monitoring Plan (Arcadis 2016).
- (2) VOC samples analyzed using USEPA Method 8260C. 1,4-dioxane samples analyzed using USEPA Method 8270D-SIM.
- (3) Total VOC results rounded to two significant figures.
- (4) Due to laboratory error a diluted analysis could not be run for the WELL 3R quarterly sample, which resulted in a reported value for TCE of 333 ug/L which exceeds the calibration range of the instrument; the associated result was qualified as estimated. The February estimated sample result is similar to results for monthly samples taken on January 10 and March 13, 2019 (301 ug/L and 304 ug/L, respectively). Additionally, the February estimated sample result is within the typical range of TCE recorded from 2017 through 2019 of 272 ug/L to 498 ug/L.
- (5) The compound 1,4-Dioxane associated with samples WELL 19 and REP-021319-RM-1 exhibited a field duplicate RPD greater than the control limit. The associated sample results for the listed compound were qualified as estimated.

2.0 Bold value indicates a detection.

< 1.3 Compound is not detected above its laboratory quantification limit.

D Concentration is based on a diluted sample analysis.

E Indicates value exceeds calibration range.

J Constituent value is estimated.

µg/L micrograms per liter

OU2 Operable Unit 2

REP Blind Replicate Sample

USEPA United States Environmental Protection Agency

VOC Volatile Organic Compound

Table 3A
 Vapor Sample Analytical Results First Quarter 2019,
 Tower 96 Treatment System
 Northrop Grumman Systems Corporation
 Operable Unit 2, Bethpage, New York



Constituents (Units in $\mu\text{g}/\text{m}^3$)	Location ID: Sample ID:	96 INFLUENT T96 INFLUENT (AA)	96 MID-EFFLUENT T96 MIDTRAIN (AA)	96 EFFLUENT T96 EFFLUENT (AA)
		2/13/2019	2/13/2019	2/13/2019
Volatile Organic Compounds (VOCs)⁽¹⁾				
1,1,1-Trichloroethane		17	4.5	4.5
1,1,2,2-Tetrachloroethane		< 0.55	< 0.55	< 0.55
1,1,2-Trichloroethane		2.6	< 0.44	< 0.44
1,1-Dichloroethane		46.1	27	21
1,1-Dichloroethene		105	98.3	65.4
1,2-Dichloroethane		2.6	0.77	0.73
1,2-Dichloropropane		108	19	2.5
Benzene		1.2	0.38 J	0.64
Bromodichloromethane		< 0.54	< 0.54	< 0.54
Bromoform		< 0.33	< 0.33	< 0.33
Bromomethane		< 0.62	< 0.62	< 0.62
Carbon Disulfide		< 0.50	3.7	< 0.50
Carbon Tetrachloride		3.1	< 0.20	< 0.20
Chlorobenzene		1.1	< 0.74	< 0.74
Chloroethane		2.4	2.3	1.6
Chloroform		17	8.3	6.8
Chloromethane		0.97	1.0	1.7
cis-1,2-Dichloroethene		145	90.0	105
cis-1,3-Dichloropropene		< 0.73	< 0.73	< 0.73
Dibromochloromethane		< 0.68	< 0.68	< 0.68
Ethylbenzene		< 0.69	< 0.69	< 0.69
Dichloromethane		0.83	0.83	0.87
Styrene		< 0.68	< 0.68	< 0.68
Tetrachloroethene		685	95.6	0.75
Toluene		0.33 J	1.3	39.6
trans-1,2-Dichloroethene		1.8	1.2	0.87
trans-1,3-Dichloropropene		< 0.73	< 0.73	< 0.73
Trichloroethylene		16,700	4,270	1,270
Trichlorotrifluoroethane (Freon 113)		125	50	58
Vinyl Chloride		24	22	16
Xylene-o		< 0.69	< 0.69	< 0.69
Xylene-m,p		< 0.69	< 0.69	0.52 J
Total VOCs⁽²⁾		17,989	4,696	1,596

Notes and abbreviations on last page.

Table 3A
Vapor Sample Analytical Results First Quarter 2019,
Tower 96 Treatment System
Northrop Grumman Systems Corporation
Operable Unit 2, Bethpage, New York



Notes and Abbreviations:

- (1) Vapor samples collected by Arcadis on the dates shown and submitted to a NYSDOH ELAP certified laboratory for VOC analyses per Modified USEPA Method TO-15.
- (2) Total VOCs represents the sum of individual concentrations of compounds detected rounded to the nearest whole number.
- 17** bold value indicates a detection
- < 0.54 Compound is not detected above its laboratory quantification limit.
- J Compound detected below its reporting limit; value is estimated.
- µg/m³ micrograms per cubic meter
- ELAP Environmental Laboratory Approval Program
- NYSDOH New York State Department of Health
- USEPA United States Environmental Protection Agency
- VOC Volatile Organic Compound

Table 3B
Vapor Sample Analytical Results First Quarter 2019,
Tower 102 Treatment System,
Northrop Grumman Systems Corporation,
Operable Unit 2, Bethpage, New York

Constituents (Units in $\mu\text{g/m}^3$)	Location ID: Sample ID:	102 INFLUENT T102 INFLUENT (AA)	102 EFFLUENT T102 EFFLUENT (AA)
		2/13/2019	2/13/2019
Volatile Organic Compounds (VOCs)⁽¹⁾			
1,1,1-Trichloroethane		8.2	0.71
1,1,2,2-Tetrachloroethane		< 0.55	< 0.55
1,1,2-Trichloroethane		0.98	< 0.44
1,1-Dichloroethane		31	27
1,1-Dichloroethene		63.0	66.6
1,2-Dichloroethane		2.5	< 0.65
1,2-Dichloropropane		5.5	< 0.74
Benzene		0.67	< 0.51
Bromodichloromethane		< 0.54	< 0.54
Bromoform		< 0.33	< 0.33
Bromomethane		< 0.62	< 0.62
Carbon Disulfide		< 0.50	< 0.50
Carbon Tetrachloride		3.3	< 0.20
Chlorobenzene		< 0.74	< 0.74
Chloroethane		< 0.42	< 0.42
Chloroform		8.8	4.2
Chloromethane		0.83	0.74
cis-1,2 Dichloroethene		187	44.8
cis-1,3-Dichloropropene		< 0.73	< 0.73
Dibromochloromethane		< 0.68	< 0.68
Ethylbenzene		< 0.69	< 0.69
Dichloromethane		0.63	1.6
Styrene		< 0.68	< 0.68
Tetrachloroethene		272	< 0.22
Toluene		0.49 J	0.49 J
trans-1,2-Dichloroethene		1.9	0.63
trans-1,3-Dichloropropene		< 0.73	< 0.73
Trichloroethylene		2,230	16
Trichlorotrifluoroethane (Freon 113)		47	61
Vinyl Chloride		< 0.082	0.21
Xylene-o		< 0.69	< 0.69
Xylene-m,p		0.48 J	< 0.69
Total VOCs⁽²⁾		2,864	224

Notes and abbreviations on last page.

Table 3B
Vapor Sample Analytical Results First Quarter 2019,
Tower 102 Treatment System,
Northrop Grumman Systems Corporation,
Operable Unit 2, Bethpage, New York

Notes and Abbreviations:

- (1) Vapor samples collected by Arcadis on the dates shown and submitted to a NYSDOH ELAP certified laboratory for VOC analyses per Modified USEPA Method TO-15.
- (2) Total VOCs represents the sum of individual concentrations of compounds detected rounded to the nearest whole number.
- 5.5** bold value indicates a detection
- < 0.68 Compound is not detected above its laboratory quantification limit.
- J Compound detected below its reporting limit; value is estimated.
- µg/m³ micrograms per cubic meter
- ELAP Environmental Laboratory Approval Program
- NYSDOH New York State Department of Health
- USEPA United States Environmental Protection Agency
- VOC volatile organic compound

Table 4A
Summary of AERMOD Air Quality Impact Analysis
Tower 96 Treatment System, Operable Unit 2,
Northrop Grumman Systems Corporation,
Bethpage, New York

Constituent	CAS#	T96 Effluent ($\mu\text{g}/\text{m}^3$)	Emission Rate ⁽¹⁾			Scaled Impact - Hourly ⁽²⁾ ($\mu\text{g}/\text{m}^3$)	Scaled Impact - Annual ⁽³⁾ ($\mu\text{g}/\text{m}^3$)	SGC ⁽⁴⁾ ($\mu\text{g}/\text{m}^3$)	AGC ⁽⁵⁾ ($\mu\text{g}/\text{m}^3$)	%SGC	% AGC
			2/13/2019	lb/yr	lb/hr						
1,1,1 - Trichloroethane	00071-55-6	4.5	0.72	8.21E-05	1.03E-05	1.53E-03	4.50E-05	9,000	5000.00	0.00%	0.00%
1,1 - Dichloroethane	00075-34-3	21	3.36	3.83E-04	4.83E-05	7.15E-03	2.10E-04	--	0.63	--	0.03%
1,2 - Dichloroethane	00107-06-2	0.73	0.12	1.33E-05	1.68E-06	2.49E-04	7.29E-06	--	0.04	--	0.02%
1,1 - Dichloroethene	00075-35-4	65.4	10.46	1.19E-03	1.50E-04	2.23E-02	6.53E-04	--	200.00	--	0.00%
Tetrachloroethylene	00127-18-4	0.75	0.12	1.37E-05	1.72E-06	2.55E-04	7.49E-06	300	4.00	0.00%	0.00%
Trichloroethylene ⁽⁴⁾	00079-01-6	1,270	203	2.32E-02	2.92E-03	4.32E-01	1.27E-02	20	0.20	2.16%	6.34%
Vinyl Chloride ⁽⁴⁾	00075-01-4	16	2.56	2.92E-04	3.68E-05	5.45E-03	1.60E-04	180,000	0.11	0.00%	0.15%
cis 1,2-Dichloroethene	00156-59-2	105	16.79	1.92E-03	2.41E-04	3.57E-02	1.05E-03	--	63.00	--	0.00%
trans 1,2-Dichloroethene	00156-60-5	0.87	0.14	1.59E-05	2.00E-06	2.96E-04	8.69E-06	--	63.00	--	0.00%
Benzene ⁽⁴⁾	00071-43-2	0.64	0.10	1.17E-05	1.47E-06	2.18E-04	6.39E-06	1,300	0.13	0.00%	0.00%
Toluene	00108-88-3	39.6	6.33	7.23E-04	9.11E-05	1.35E-02	3.96E-04	37,000	5000.00	0.00%	0.00%
Xylenes - m,p	01330-20-7	0.52	0.08	9.49E-06	1.20E-06	1.77E-04	5.20E-06	22000	100.00		0.00%
1,2-Dichloropropane	00078-87-5	2.5	0.40	4.56E-05	5.75E-06	8.51E-04	2.50E-05	--	4.00	--	0.00%
Chloroethane	00078-93-14	1.6	0.26	2.92E-05	3.68E-06	5.45E-04	1.60E-05	--	10000.00	--	0.00%
Chloroform	00078-93-15	6.8	1.09	1.24E-04	1.56E-05	2.31E-03	6.79E-05	150	14.70	0.00%	0.00%
Chloromethane	00078-93-16	1.7	0.27	3.10E-05	3.91E-06	5.79E-04	1.70E-05	22,000	90.00	0.00%	0.00%
Dichloromethane	00078-93-19	0.87	0.14	1.59E-05	2.00E-06	2.96E-04	8.69E-06	14,000	60.00	0.00%	0.00%
Trichlorotrifluoroethane (Freon 113)	00078-93-26	58	9.27	1.06E-03	1.33E-04	1.97E-02	5.79E-04	960,000	180000.00	0.00%	0.00%

Notes and Abbreviations on next page

Table 4A
Summary of AERMOD Air Quality Impact Analysis
Tower 96 Treatment System, Operable Unit 2,
Northrop Grumman Systems Corporation,
Bethpage, New York



Notes and Abbreviations:

(1) Emission rate calculated based on effluent concentration and a stack air flow rate of 4,839 cfm. The stack air flow rate (in acfm) is taken from the actual stack air flow rate on 2/13/19.
Effluent temperature used in the model was 92°F from direct read in-line gauge.

$$\text{Trichloroethene (lb/hr)} = (720 \text{ ug/m}^3) \times (4,839 \text{ ft}^3/\text{min}) \times (1 \text{ m}^3/35 \text{ ft}^3) \times (60 \text{ min/hr}) \times (0.000001 \text{ g/1 ug}) \times (0.0022 \text{ lb/g})$$

$$\text{lb/yr} = \text{lb/hr} \times 8,760 \text{ hrs/yr}$$

$$\text{g/s} = \text{lb/hr} \times 1 \text{ hr}/3,600 \text{ sec} \times 453.59 \text{ g/1 lb}$$

(2) Ambient impact based on AERMOD modeling using normalized rate of 1 g/s is scaled to the actual emission rate of the pollutant. Modeling was performed using the representative meteorological data from the nearest station (Farmingdale, NY) for the years 2011 through 2015, and a stack which is 55 feet high and 20 inches in diameter. The maximum impact from all the years was used for the calculations.

$$\text{Scaled hourly impact (ug/m}^3) = \text{AERMOD predicted hourly ambient impact at 1 g/s ([ug/m}^3]/[g/s]) \times \text{Actual emission rate (g/s)}$$

$$\text{Scaled annual impact (ug/m}^3) = \text{AERMOD predicted annual ambient impact at 1 g/s ([ug/m}^3]/[g/s]) \times \text{Actual emission rate (g/s)}$$

AERMOD Normalized Ambient Impact at 1 g/s	
Hourly	Annual
(ug/m ³)/g/s)	(ug/m ³)/g/s)
148.05	4.35

(3) Short-term and annual guideline concentrations for air toxic pollutants specified in the NYSDEC DAR-1 AGC/SGC tables revised August 10, 2016.

(4) Vinyl Chloride and Benzene potential emission rates are less than 0.1 lb/hr and therefore below the trigger emissions for degree of air cleaning requirement (6 CRR-NY 212-2.3). TCE potential emissions are above the trigger limit and require a 12 month rolling average of annual emission to be maintained (see Table 5A) to demonstrate compliance with the 6 CRR-NY 212-2.2 500 lb/year requirement.

AGC	Annual Guideline Concentration	4.5	bold value indicates a detection
CAS #	Chemical Abstracts Service Registry Number	acfm	actual cubic feet per minute
CRR-NY	New York Codes, Rules and Regulations	g/s	grams per second
DAR-1	Division of Air Resources-1	ug/m ³	micrograms per cubic meter
--	None Specified	lb/yr	pounds per year
NYSDEC	New York State Department of Environmental Conservation	lb/hr	pounds per hour
SGC	Short-term Guideline Concentration		

Table 4B
Summary of AERMOC Air Quality Impact Analysis
Tower 102 Treatment System, Operable Unit 2,
Northrop Grumman Systems Corporation,
Bethpage, New York



Constituent	CAS#	T102 Effluent ($\mu\text{g}/\text{m}^3$)	Emission Rate ^(b)			Scaled Impact- Hourly ^(d) ($\mu\text{g}/\text{m}^3$)	Scaled Impact- Annual ^(e) ($\mu\text{g}/\text{m}^3$)	SGC ^(f) ($\mu\text{g}/\text{m}^3$)	AGC ^(g) ($\mu\text{g}/\text{m}^3$)	%SGC	%AGC
			2/13/2019	lb/yr	lb/hr						
1,1,1 - Trichloroethane	00071-55-6	0.71	0.18	2.10E-05	2.65E-06	9.24E-04	6.05E-06	9000	5000.00	0.00%	0.00%
1,1 - Dichloroethane	00075-34-3	27	7.00	8.00E-04	1.01E-04	3.51E-02	2.30E-04	--	0.63	--	0.04%
1,1 - Dichloroethene	00075-35-4	66.6	17.28	1.97E-03	2.48E-04	8.67E-02	5.68E-04	--	200.00	--	0.00%
Trichloroethylene ⁽⁴⁾	00079-01-6	16	4.15	4.74E-04	5.97E-05	2.08E-02	1.36E-04	20	0.20	0.10%	0.07%
Vinyl Chloride ⁽⁴⁾	00075-01-4	0.21	0.05	6.22E-06	7.84E-07	2.73E-04	1.79E-06	180,000	0.11	0.00%	0.00%
cis-1,2-Dichloroethene	00156-59-2	44.8	11.62	1.33E-03	1.67E-04	5.83E-02	3.82E-04	--	63.00	--	0.00%
trans-1,2-Dichloroethene	00156-60-5	0.63	0.16	1.87E-05	2.35E-06	8.20E-04	5.37E-06	--	63.00	--	0.00%
Toluene	00108-88-3	0.49	0.13	1.45E-05	1.83E-06	6.38E-04	4.18E-06	37000	50000.00	--	0.00%
Chloroform	00067-66-3	4.2	1.09	1.24E-04	1.57E-05	5.47E-03	3.58E-05	150	14.70	0.00%	0.00%
Chloromethane	00074-87-3	0.74	0.19	2.19E-05	2.76E-06	9.63E-04	6.31E-06	22,000	90.00	0.00%	0.00%
Dichloromethane	00075-09-2	1.6	0.42	4.74E-05	5.97E-06	2.08E-03	1.36E-05	14,000	60.00	0.00%	0.00%
Trichlorotrifluoroethane (Freon 113)	00076-13-1	61	15.82	1.81E-03	2.28E-04	7.94E-02	5.20E-04	960,000	1800000.00	0.00%	0.00%

Table 4B
 Summary of AERMOD Air Quality Impact Analysis
 Tower 102 Treatment System, Operable Unit 2,
 Northrop Grumman Systems Corporation,
 Bethpage, New York



Notes and Abbreviations:

(1) Emission rate calculated based on effluent concentration and a stack air flow rate of 7,852 cfm. The stack air flow rate (in acfm) is taken from the actual stack air flow rate on 2/13/2019.
 Effluent temperature used in the model was 80°F from direct read in-line gauge.

$$\text{Trichloroethene (lb/hr)} = (21 \text{ ug/m}^3) \times (7,919 \text{ ft}^3/\text{min}) \times (1 \text{ m}^3/35 \text{ ft}^3) \times (60 \text{ min/hr}) \times (0.000001 \text{ g/1 ug}) \times (0.0022 \text{ lb/g})$$

$$\text{lb/yr} = \text{lb/hr} \times 8,760 \text{ hrs/yr}$$

$$\text{g/s} = \text{lb/hr} \times 1 \text{ hr}/3,600 \text{ sec} \times 453.59 \text{ g/1 lb}$$

(2) Ambient impact based on AERMOD modeling using noramlized rate of 1 g/s is scaled to the actual emission rate of the pollutant. Modeling was performed using the representative meteorological data from the nearest station (Farmingdale, NY) for the years 2011 through 2015, and a stack which is 69.52 feet high and 24 inches in diameter. The maximum impact from all the years was used for the calculations.

$$\text{Scaled hourly impact } (\text{ug/m}^3) = \text{AERMOD predicted hourly ambient impact at 1 g/s } ([\text{ug/m}^3]/[\text{g/s}]) \times \text{Actual emission rate (g/s)}$$

$$\text{Scaled annual impact } (\text{ug/m}^3) = \text{AERMOD predicted annual ambient impact at 1 g/s } ([\text{ug/m}^3]/[\text{g/s}]) \times \text{Actual emission rate (g/s)}$$

AERMOD Normalized Ambient Impact at 1 g/s	
Hourly ([\text{ug/m}^3]/[\text{g/s}])	Annual ([\text{ug/m}^3]/[\text{g/s}])
348.85	2.29

(3) Short-term and annual guideline concentrations for air toxic pollutants specified in the NYSDEC DAR-1 AGC/SGC tables revised August 10, 2016.

(4) Vinyl Chloride potential emission rate is less than 0.1 lb/hr and therefore below the trigger emissions for degree of air cleaning requirement (6 CRR-NY 212-2.3). TCE potential emissions are above the trigger limit and require a 12 month rolling average of annual emission to be maintained (see Table 5B) to demonstrate compliance with the 6 CRR-NY 212-2.2 500 lb/year requirement.

AGC	Annual Guideline Concentration	16	bold value indicates a detection
CAS #	Chemical Abstracts Service Registry Number	acfm	actual cubic feet per minute
CRR-NY	New York Codes, Rules and Regulations	g/s	grams per second
DAR-1	Division of Air Resources-1	µg/m ³	micrograms per cubic meter
--	None Specified	lb/yr	pounds per year
NYSDEC	New York State Department of Environmental Conservation	lb/hr	pounds per hour
SGC	Short-term Guideline Concentration		

Table 5A
Summary of TCE Mass Removal, Tower 96 Treatment System,
2019, Northrop Grumman Systems Corporation,
Operable Unit 2, Bethpage, New York^(1,2,3)

Date	TCE Concentration ($\mu\text{g}/\text{m}^3$)				TCE Mass Emission ⁽⁴⁾	Percent of Allowable TCE Emissions ⁽⁵⁾
	T96 INFLUENT	T96 MIDTRAIN	T96 SUP MIDTRAIN	T96 EFFLUENT	(lbs)	12 Month Rolling Average
1/31/2018	NS	3,510	2,710	17	0.4	91.3%
2/28/2018	13,000	2,860	3,930	86.5	1.0	91.4%
4/13/2018 ⁽⁴⁾	13,000	NS	NS	232	4.4	52.9%
5/15/2018	17,400	5,430	14	1,590	22	44.5%
9/5/2018 ⁽⁵⁾	18,700	3,650	NS	693	34	20.0%
12/7/2018	14,400	3,190	NS	720	29	18.1%
2/13/2019	16,700	4,270	NS	1,270	7.0	25.4%

Notes and Abbreviations:

- (1) Vapor samples collected by Arcadis on the dates shown and submitted to a NYSDOH ELAP certified laboratory for VOC analyses per Modified USEPA Method TO-15.
- (2) TCE Mass Emission calculated based on the exhaust air flow rate on the day of sampling and the period of time since the preceding day of sampling.
- (3) TCE (lb) = TCE Concentration [$\mu\text{g}/\text{m}^3$] x Days x Flow Rate [ft^3/min] x ($1 \text{ m}^3/35 \text{ ft}^3$) x (60 min/hr) x (24 hr/day) x (0.000001 g/1 ug) x (0.0022 lb/g)
- (4) Percent of allowable TCE emissions to date is a time-weighted annual rolling average based on the 500 lb/year emission limit specified in the CRR-NY 212-2.2 Table 2. High Toxicity Air Contaminant List, revised April 1, 2017.
- (4) Carbon changeout for Tower 96 lead supplemental bed was completed on April 6, 2018.
- (5) Regenerative Carbon changeout for Tower 96 was completed on July 28, 2018.

$\mu\text{g}/\text{m}^3$ micrograms per cubic meter

lbs pounds

CRR-NY Codes, Rules and Regulations of the State of New York

ELAP Environmental Laboratory Approval Program

NS Not Sampled

NYSDOH New York State Department of Health

SUP Supplemental

TCE Trichloroethylene

USEPA United States Environmental Protection Agency

VOC Volatile Organic Compound

Table 5B
Summary of TCE Mass Removal, Tower 102 Treatment System,
2019, Northrop Grumman Systems Corporation, Operable Unit 2,
Bethpage, New York^(1,2,3)

Date	TCE Concentration ($\mu\text{g}/\text{m}^3$)		TCE Mass Emission ^(1,2)		Percentage of Allowable TCE Emissions ⁽³⁾	
	T102 INFLUENT	T102 EFFLUENT	lbs	lbs/day	Period	12 Month Rolling Average
2/28/2018	2,970	4	0.2	0.00	0.2%	0.9%
5/10/2018	1,710	2	0.1	0.00	0.1%	1.2%
9/5/2018 ⁽⁴⁾	3,480	1	0.1	0.00	0.1%	0.4%
12/7/2018	2,380	21	1.4	0.01	1.1%	0.4%
2/13/2019	2,230	16	0.8	0.01	0.8%	0.5%

Notes and Abbreviations:

- (1) Vapor samples collected by Arcadis on the dates shown and submitted to a NYSDOH ELAP certified laboratory for VOC analyses per Modified USEPA Method TO-15.
- (2) TCE Mass Emission calculated based on the exhaust air flow rate on the day of sampling and the period of time since the preceding sampling day.
- (3) TCE (lb) = TCE Concentration [$\mu\text{g}/\text{m}^3$] x Days x Flow Rate [ft^3/min] x (1 $\text{m}^3/35 \text{ ft}^3$) x (60 min/hr) x (24 hr/day) x (0.000001 g/1 ug) x (0.0022 lb/g)
- (4) Percent of allowable TCE emissions to date is a time-weighted annual rolling average based on the 500 lb/year emission limit specified in the CRR-NY 212-2.2 Table 2. High Toxicity Air Contaminant List, revised April 1, 2017.

$\mu\text{g}/\text{m}^3$ micrograms per cubic meter

lbs pounds

ELAP Environmental Laboratory Approval Program

NYSDOH New York State Department of Health

T102 Tower 102

TCE trichloroethene

USEPA United States Environmental Protection Agency

VOC volatile organic compound

Table 6
 Concentrations of Volatile Organic Compounds
 and 1,4-Dioxane in Monitoring Wells⁽¹⁾
 BPOW 2-1, BPOW 2-2 and BPOW 2-3, First Quarter 2019,
 Operable Unit 2 (Groundwater),
 Bethpage, New York

CONSTITUENT Units (ng/L)	Location ID: Sample ID: Date:	BPOW 2-1 BPOW 2-1 2/18/2019	BPOW 2-2 BPOW 2-2 2/18/2019	BPOW 2-3 BPOW 2-3 2/18/2019
Volatile Organic Compounds (VOCs)^(2,3)				
1,1,1-Trichloroethane		< 0.50	< 0.50	< 0.50
1,1,2,2-Tetrachloroethane		< 0.50	< 0.50	< 0.50
1,1,2-trichloro-1,2,2-trifluoroethane		< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane		< 0.50	< 0.50	< 0.50
1,1-Dichloroethane		< 0.50	< 0.50	< 0.50
1,1-Dichloroethene		< 0.50	< 0.50	< 0.50
1,2-Dichloroethane		< 0.50	< 0.50	< 0.50
1,2-Dichloropropane		< 0.50	< 0.50	< 0.50
2-Butanone (MEK)		< 5.0	< 5.0	< 5.0
2-Hexanone		< 2.0	< 2.0	< 2.0
4-methyl-2-pentanone (MIK)		< 2.0	< 2.0	< 2.0
Acetone		< 5.0	< 5.0	< 5.0
Benzene		< 0.50	< 0.50	< 0.50
Bromodichloromethane		< 0.50	< 0.50	< 0.50
Bromoform		< 0.50	< 0.50	< 0.50
Bromomethane		< 0.50	< 0.50	< 0.50
Carbon Disulfide		< 0.50	< 0.50	< 0.50
Carbon tetrachloride		< 0.50	< 0.50	< 0.50
Chlorobenzene		< 0.50	< 0.50	< 0.50
Chloroethane		< 0.50	< 0.50	< 0.50
Chloroform		< 0.50	< 0.50	< 0.50
Chloromethane		< 0.50	< 0.50	< 0.50
cis-1,2-dichloroethene		< 0.50	< 0.50	< 0.50
cis-1,3-dichloropropene		< 0.50	< 0.50	< 0.50
Dibromochloromethane		< 0.50	< 0.50	< 0.50
Ethylbenzene		< 0.50	< 0.50	< 0.50
Methylene Chloride		< 0.50	< 0.50	< 0.50
Styrene		< 0.50	< 0.50	< 0.50
Tetrachloroethene		< 0.50	< 0.50	< 0.50
Toluene		< 0.50	< 0.50	< 0.50
trans-1,2-dichloroethene		< 0.50	< 0.50	< 0.50
trans-1,3-dichloropropene		< 0.50	< 0.50	< 0.50
Trichloroethylene		< 0.50	< 0.50	< 0.50
Vinyl Chloride		< 0.50	< 0.50	< 0.50
Xylene-o		< 0.50	< 0.50	< 0.50
Xylenes - m,p		< 0.50	< 0.50	< 0.50
Total VOCs		0	0	0
1,4-Dioxane^(2,3)		0.644	0.475	3.19

See last page for Notes and Abbreviations.

Table 6
Concentrations of Volatile Organic Compounds
and 1,4-Dioxane in Monitoring Wells⁽¹⁾
BPOW 2-1, BPOW 2-2 and BPOW 2-3, First Quarter 2019,
Operable Unit 2 (Groundwater),
Bethpage, New York



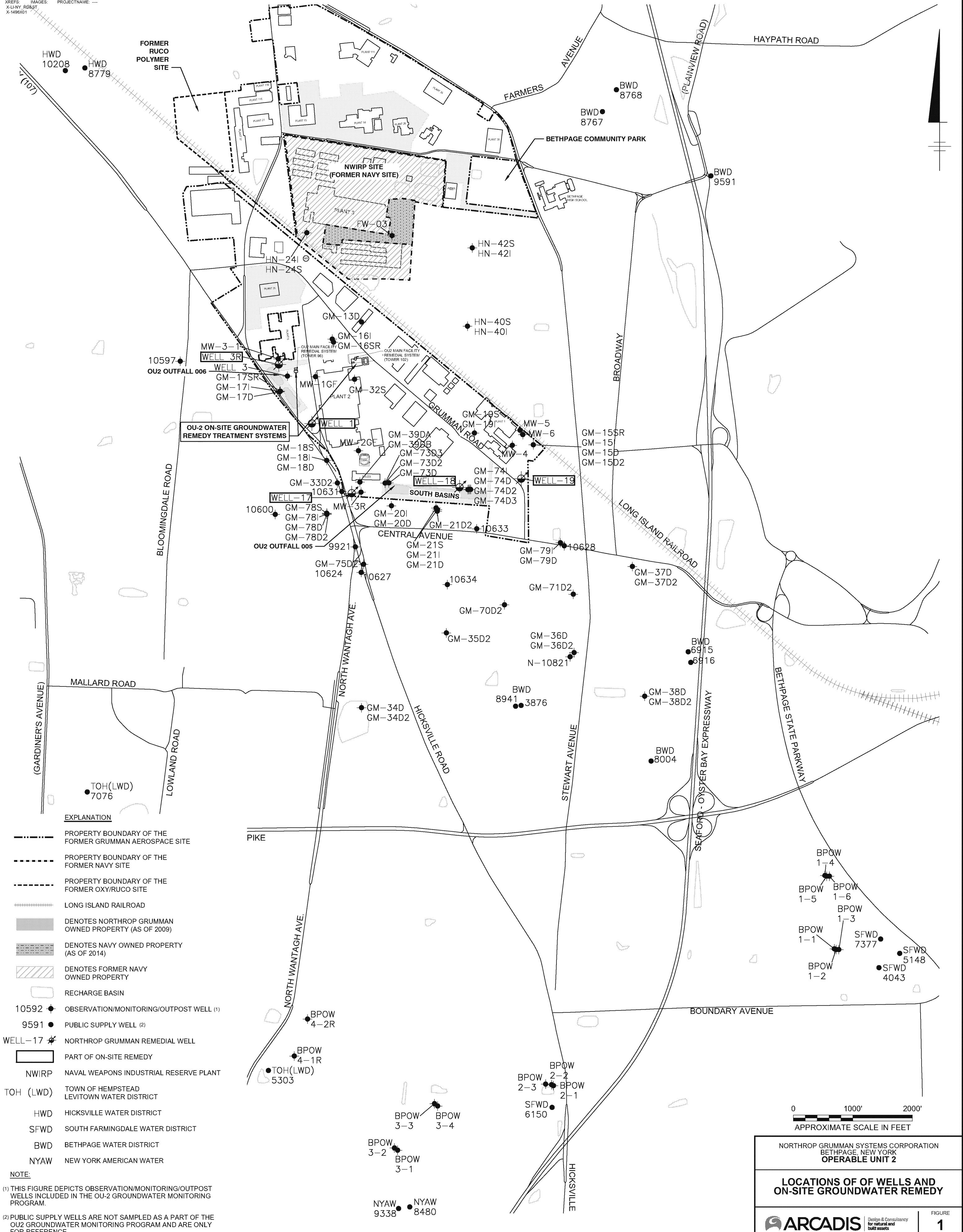
Notes and Abbreviations:

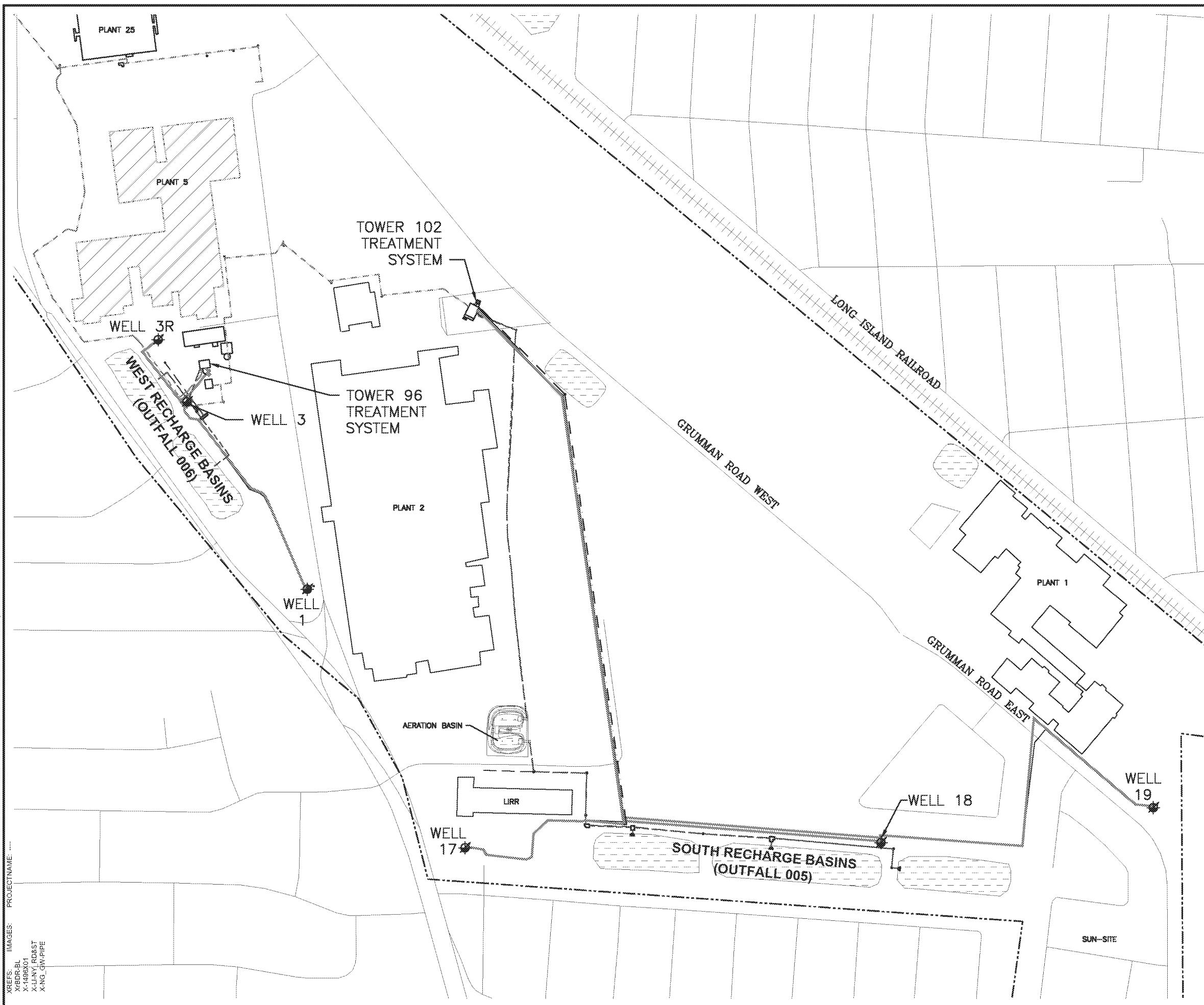
- (1) These outpost wells have been recently repurposed for use as plume monitoring wells per the June 2015 Groundwater Monitoring Plan Addendum (ARCADIS of New York, Inc., 2015) as conditionally approved by the NYSDEC (August 25, 2015). Therefore, TVOC trigger levels that may have been previously established are no longer shown
- (2) Samples were analyzed for VOCs using USEPA Method 524.2; samples were analyzed for 1,4-Dioxane using USEPA Method 522
- (3) Results for the program are validated at 20% frequency, per protocols specified in the OU2 Groundwater Monitoring Plan (Arcadis 2016)

0.644 Bold value indicates a detection
VOC Volatile Organic Compound
 $\mu\text{g/L}$ micrograms per liter
<0.5 Compound not detected above its laboratory quantification limit

FIGURES







LEGEND:

- - - - FORMER NORTHROP GRUMMAN
 PROPERTY LINE
 - - - - - INFLUENT LINE
 - - - - - BYPASS
 - - - - - STORM DRAIN (EFFLUENT)
 - - - - - NON POTABLE WATER
 DISTRIBUTION LINE (EFFLUENT)
 + + + + RAILROAD TRACKS
 - - x - - FENCE
 WELL 1B# REMEDIAL WELL
 (oval) BASIN
 ON-SITE CONTAMINANT

NOTES:

DRAWING IS NOT TO BE USED
FOR DESIGN PURPOSES. LAYOUT
OF PIPING IS FOR
REPRESENTATION ONLY
(LOCATIONS ARE APPROXIMATE).

NORTHROP GRUMMAN SYSTEMS CORPORATION
BETHPAGE, NEW YORK
OPERABLE UNIT 2

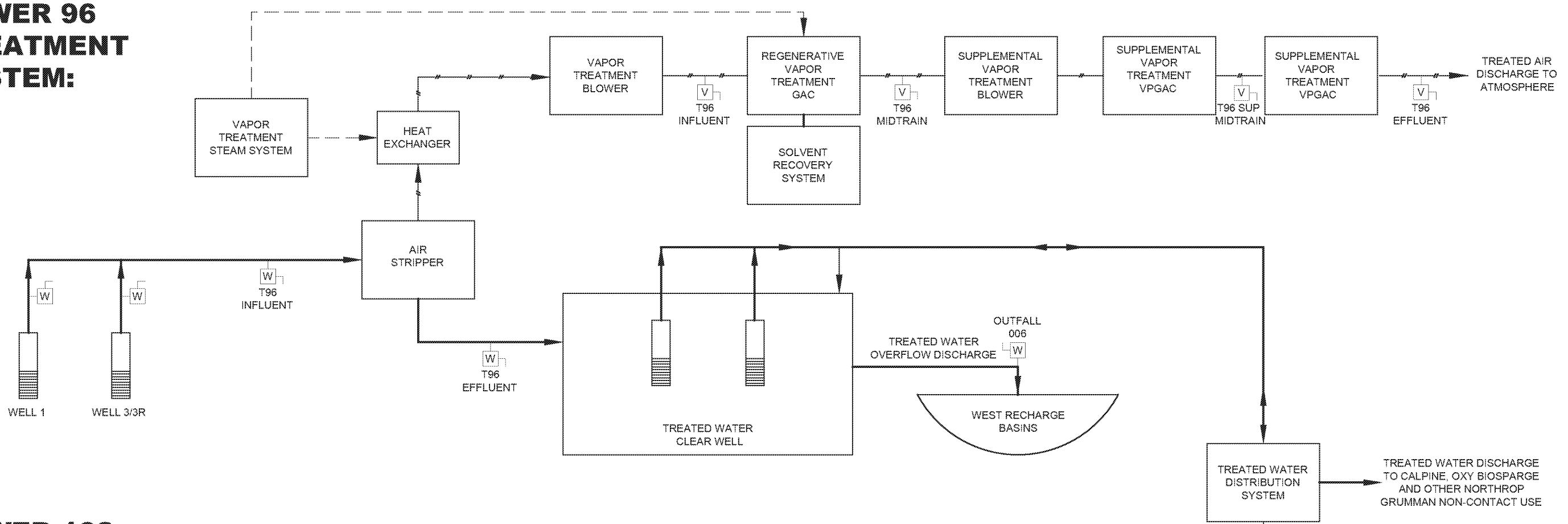
ONCT GROUNDWATER EXTRACTION AND TREATMENT SYSTEM SITE PLAN

 ARCADIS

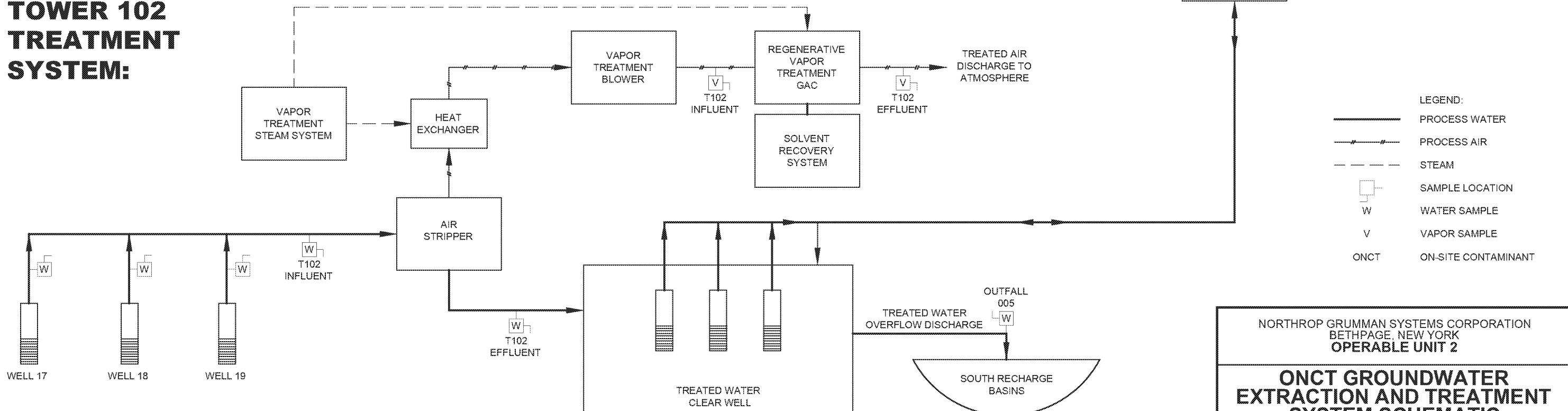
Design & Consultancy
for natural and
built assets

**FIGURE
2**

TOWER 96 TREATMENT SYSTEM:



TOWER 102 TREATMENT SYSTEM:



NORTHROP GRUMMAN SYSTEMS CORPORATION
BETHPAGE, NEW YORK
OPERABLE UNIT 2
**ONCT GROUNDWATER
EXTRACTION AND TREATMENT
SYSTEM SCHEMATIC**